glide patterns. When objects **10** and **20** are not aligned in a common vertical or horizontal axis, there may be ambiguity in identifying glide patterns, as illustrated in FIGS. **3**A and **3**B. In case of such ambiguity, and as described hereinabove with reference to FIGS. **2**B and **2**C, discriminating between FIG. **3**A and FIG. **3**B is resolved by either (i) associating the same meaning to both glide patterns, or else (ii) by associating meaning to only one of the two glide patterns.

[0068] It will be appreciated by those skilled in the art that the present invention also identifiers three or more objects that are simultaneously touching touch screen **100**. Reference is now made to FIGS. **4**A-**4**C, which are diagrams of a touch screen for a piano keyboard simulator, that detects multiple keys of a displayed piano keyboard that are touched simultaneously, in accordance with an embodiment of the present invention. The touch screen in FIGS. **4**A-**4**C has a different layout than the touch screen in FIGS. **1**-**3**. Piano keys are displayed along a horizontal axis. As such, touch positions along the horizontal axis correspond to keys of the keyboard. The black keys are identified by their positions that straddle two white keys.

[0069] The hand shown in FIG. **4**A is playing three white keys, and correspondingly the PD receivers denoted a-f are blocked. The hand shown in FIG. **4**B is playing two white keys and one black key, and correspondingly a different plurality of PD receivers, also denoted a-f, are blocked. The hand shown in FIG. **4**C is playing four white keys with three fingers. The same PD receivers a-f as in FIG. **4**B are blocked in FIG. **4**C. In this case, the PD receivers along the right edge of touch screen **100** discriminate between FIG. **4**B and FIG. **4**C; namely, PD receivers g, h and i are blocked in FIG. **4**B, where PD receivers g and h are blocked in FIG. **4**C. Blocked PD receiver i in FIG. **4**B indicates a depth corresponding to a black piano key.

[0070] Reference is now made to FIG. **5**, which is a circuit diagram of touch screen **100** from FIG. **1**, in accordance with an embodiment of the present invention. The LEDs **130** and PDs **140** are controlled by a controller, shown in FIG. **6**A. The LEDs receive respective signals LED00-LED15 from LED switches A, and receive current from VROW and VCOL through current limiters B. Operation of LED switches A is described with reference to FIG. **12**. Operation of current limiters B is described with reference to FIGS. **11**A and **11**B. The PDs receive respective signals PD01-PD15 from shift register **120**. PD output is sent to controller **150**, via signals PDROW and PDCOL.

[0071] According to one embodiment of the present invention, the LEDs are controlled via a first serial interface, which transmits a binary string to a shift register **110**. Each bit of the binary string corresponds to one of the LEDs, and indicates whether to activate or deactivate the corresponding LED, where a bit value "1" indicates activation and a bit value "0" indicates deactivation. Successive LEDs are activated and deactivated by shifting the bit string within shift register **110**. Operation of shift register **110** is described with reference to FIG. **8**.

[0072] Similarly, the PDs are controlled by a second serial interface, which transmits a binary string to a shift register **120**. Successive PDs are activated and deactivated by shifting the bit string in shift register **120**. Operation of shift register **120** is described with reference to FIG. **14**.

[0073] According to another embodiment of the present invention, shown in FIG. **11**, the LEDs are logically arranged in a matrix with signals controlling each row and each column in the LED matrix. Each LED matrix signal is connected to a separate pin of a controller. Similarly, as shown in FIG. **16**, the PDs may be logically arranged in a matrix with signals controlling each row and each column in the PD matrix.

[0074] The ensuing description addresses (1) the electronics, (2) the optics, and (3) applications of touch screen **100**.

1. Electronics of Touch Screen **100**

[0075] Reference is now made to FIG. **6**A, which is a simplified block diagram of electronics for touch screen **100**, in accordance with an embodiment of the present invention. As shown in FIG. **6**A, touch screen **100** includes light-emitting diodes **130**, which emit pulses of infra-red light, and photodiodes **140**, which detect light intensity. LEDs **130** are selectively activated in a controlled manner by a controller **150**, via LED selectors **160** and LED switches A. Current is supplied to LEDs **130** by current limiters B shown in FIGS. **5** and **6**A. Each LED requires approximately 2 amps of current, whereas each LED selector **160** only supplies a few milliamps. As such, each LED selector activates an LED switch A that supplies sufficient current. Operation of LED switches A is described with reference to FIG. **12**. Operation of current limiters B is described with reference to FIGS. **13**A and **13**B.

[0076] Controller **150** also selectively filters PDs **140** in a controlled manner, via PD selectors **170**. PDs **140** are selectively activated by PD selectors **170**, which activate one of the PDs. The signal from the activated PD is transmitted back to controller **150** via a current integrator **180**, which then determines whether or not one or more objects are placed over touch screen **100** and, if so, the positions of the objects. According to an embodiment of the present invention, the signal from the activated PD is transmitted to a signal filter and amplifier **175**. The output of signal filter and amplifier **175** is transmitted back to controller **150**, which then determines whether or not one or more objects are placed over touch screen **100** and, if so, the positions of the objects. Operation of signal filter and amplifier **175** is described with reference to FIGS. **23**A and **23**B. Operation of current integrator **180** is described with reference to FIGS. **18**A and **18**B.

[0077] Reference is now made to FIG. **6**B, which is a simplified block diagram of alternate electronics for touch screen **100**, in accordance with an embodiment of the present invention. The diagram of FIG. **6**B includes an optional multiplexer **171**, used to select one from among several PD output signals. In the absence of multiplexer **171**, inactive PD signals may affect the signal entering controller **150** and optional filter and amplifier **175**. Multiplexer **171** eliminates these effects. Operation of multiplexer **171** is described with reference to FIG. **17**.

[0078] i. Controller **150**

[0079] As used herein, the term "controller" includes inter alia programmable processors, RISC processors, dedicated hardware, field programmable gate arrays (FPGA) and application-specific circuits (ASIC). Although FIGS. **6**A and **6**B show current integrator **180**, signal filter and amplifier **175**, PD selectors **170**, LED selectors **160** and other functional blocks as being external to controller **150**, such implementation is for purposes of clarity and exposition. However, it will be appreciated by those skilled in the art that in other implementations of the present invention some or all of these blocks, or portions thereof, may be integrated within controller **150**.

[0080] Reference is now made to FIG. **7**, which is a simplified circuit diagram of an exemplary controller **150** for use